

Research article

Correlation of condylar kinematics in children with gender, facial type and weight

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ABSTRACT

Objective: The aim of the study has been to describe the normal range of mandibular movements and condylar kinematics in children as well as to test the null hypothesis that these variables are not associated with gender, facial type and weight.

Materials and methods: The sample was comprised of 92 healthy children (7.2–10.6 years old) and 40 adult controls (18–34.7 years old). Examinations included the maximal mouth opening capacity and laterotrusion to the right and to the left. The condylar path inclination angle was calculated at 3 mm and 5 mm protrusion of the mandible. Kinematic variables were registered using the ultrasonic JMA system. **Results:** Maximal mouth opening capacity averaged 46.73 mm for the children and 53.53 mm for the adults. The mean values of the lateral movements were 9.36 mm to the right and 9.62 mm to the left for the boys, and 9.91 mm and 9.68 mm for the girls, respectively. Mean condylar path inclination in the children was 36.5° (right) and 36.2° (left) at 3 mm of protrusive movement, and 34.3° (right) and 34.0° (left) at 5 mm of protrusive movement. Associations of the kinematic variables with gender, weight, or facial type were insignificant.

Conclusion: Younger school children have not yet reached the maximum mouth-opening capacity. Correlation analysis suggests some weak, but insignificant associations of gender, facial type and weight with mouth opening, laterotrusion and the condylar path inclination angle. The null hypothesis was not rejected.

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1. Introduction

Jaw opening capacity is considered to be one of the most important indicators of mandibular and temporomandibular joint (TMJ) function (Fanghänel et al., 2006; Fanghänel and Gedrange, 2007; Tymofiyeva et al., 2007). Reduced or excessive mandibular mobility may indicate temporomandibular disorder. However, the relationship between mouth opening capacity and TMJ dysfunction is a matter of controversy (Rosenbaum, 1975; Rieder, 1978; Hesse et al., 1996).

Numerous studies have dealt with what is supposed to be a physiological mouth opening capacity. The most important findings have been provided by Posselt (1952) who found normal mouth opening to average 43.4 mm, by Travell (1960) who measured 53 mm for women and 59 mm for men, and by Sheppard (Sheppard and Sheppard, 1965) who reported 46.9 mm. The range

of motion is theoretically affected by many factors such as the condition of joint and muscle structure, gender, age, body weight and height (Boozer et al., 1984; Gallagher et al., 2004).

This study aims to describe the normal range of mandibular and condylar kinematics in children and to test the null hypothesis that these variables are not associated with gender, facial type and weight.

2. Materials and methods

In this study, the test group consisted of 92 untreated children (48 males, 44 females) ranging from 7.2 to 10.6 years of age, and the control group consisted of 40 adults (20 males, 20 females) ranging in age from 18 to 34.7 years. All adults had full permanent dentitions, without extended prosthetic restorations and normal temporomandibular joint function. The children were examined at two elementary schools. The selection of the children was randomized among those for whom parental permission had been given. For the control group, volunteers were randomly recruited from the staff of the university dental school.

Written, informed consent was obtained from the children's parents and the adult subjects according to the guidelines of the local ethics committee and the Declaration of Helsinki and the study was approved by the ethics committee of the university clinic.

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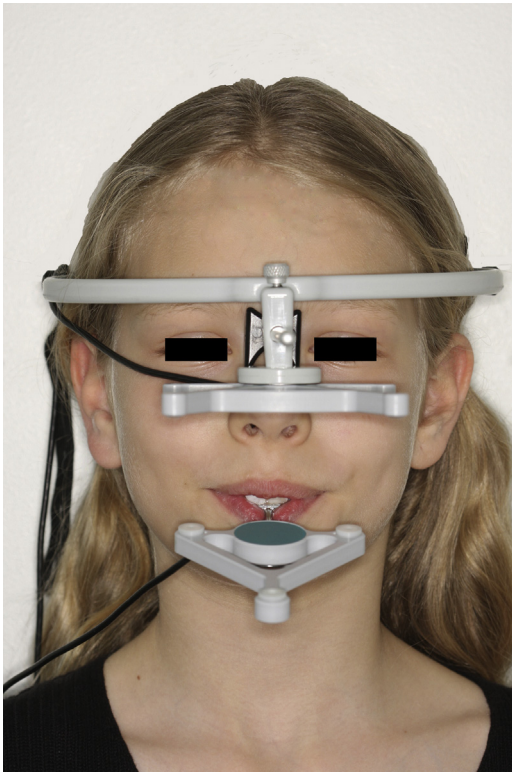


Fig. 1. En face photo of a patient with the device positioned on the head.

The examination comprised both a clinical and an instrumental segment. The Jaw Motion Analyser (JMA)[®] system (ver. 10.05.03, Zebris Medical GmbH, Isny, Germany) enabled contactless 3D recording of mandibular movements with six degrees of freedom at a sampling frequency of 75 Hz. Its principle is based on measuring the travel time of ultrasound impulses, i.e., the real-time latency period of sequentially transmitted ultrasound pulses. The system consists of a face bow where the four integrated receiver sensors are fixed and a paraocclusal metal bite fork where the three sending sensors are mounted with magnetic holders (Fig. 1). The system is supported by the WinJaw[®] version 10.05.03 software (Zebris Medical GmbH, Isny, Germany).

To prevent disturbing functional activity and habitual intercuspation, the bite fork was adapted before bonding to the labial surfaces of the lower front teeth and then individualized with the temporary composite Protemp[®] (3M ESPE, Seefeld, Germany). The variables examined were maximum mouth opening (MMO, measured as the linear distance of the incisal points), maximum laterotrusion to the right (LR) and to the left (LL), and the condylar path inclination angle (CPIA) upon frontal and sagittal Posselt movements. Each movement was repeated twice in order to ensure accuracy and reproducibility of the results. The subjects were asked to sit in an upright and relaxed position, looking straight ahead. Each movement should start and end in maximum intercuspation, and the subjects should perform each movement toothguided and without manipulation.

Statistical data analysis was carried out with the SPSS[™] rel. 17 software (SPSS Inc., Chicago, IL, USA). Robustness of categorical data (facial type, gender) allowed using one-way analyses of variance (ANOVA). Associations of body weight with the dependent kinematic variables were described using Spearman's rank correlation rho. In order to adjust for multiple significance testing, a conservative correction after Bonferroni (α/n_{tests}) was used establishing a rule-of-thumb significance level of $\alpha_{\text{corr}} = 0.005$.

3. Results

3.1. Kinematic variables and gender (Table 1)

The mean MMO measurements in the children were 47.72 mm for the boys and 45.65 mm for the girls. The mean values of the adults were 52.15 mm for the men and 54.91 mm for the women. The ANOVA revealed no significant differences in mouth opening between genders for both groups.

The maximum laterotrusion was not significantly associated with gender in either the children or adults. The mean LR values were 9.74 mm for the men and 8.11 mm for the women. The children showed mean values of 9.36 mm for the boys and 9.91 mm for the girls. The mean LL values were 9.31 mm for the men and 8.93 mm for the women, 9.62 mm for the boys and 9.68 mm for the girls.

Similarly, the results for the left and right CPIA were insignificant for both the adult and the children's group, even though the females indicated greater mean CPIA values compared to the males. Throughout the groups, the mean measurements were smaller for the 5 mm compared to the 3 mm protrusive path.

3.2. Kinematic variables and facial type (Table 2)

The mean MMO of the adults was 49.03 mm in the dolichofacial group, 52.98 mm in the brachyfacial group, and 55.06 mm in the normofacial group). The children showed mean measurements of 47.06 mm (dolichofacial), 46.26 mm (brachyfacial), and 46.77 mm (normofacial) respectively. The ANOVA revealed no significant difference between the facial types, either for the children or for the adult group. The results were also not significant for CPIA in both the children and adults. The mean measurements recorded for the dolichofacial children were smaller compared with the other subgroups. The measurements during the lateral movements showed no significant correlation between facial type and the maximum laterotrusion for both groups. The mean measurements in the children were 9.34 mm (LR) and 9.16 mm (LL) for the dolichofacial type, 9.86 mm (LR) and 9.75 mm (LL) for the brachyfacial type and 9.65 mm (LR) and 9.82 mm (LL) for the normofacial type. The adults showed similar results.

3.3. Kinematic variables and weight (Table 3)

There were no significant differences in mouth opening and body weight between the two groups. The children showed no substantial correlations between the kinematic variables and weight at all. In the adult group, body weight was negatively, yet insignificantly, associated with the CPIA at 3 mm and 5 mm of protrusive movement of the right condyle.

4. Discussion

The reliability of the JMA[®] device has been previously tested and proven capable of analysing complex jaw movements accurately and with high reproducibility (Hugger et al., 2001; Weßling et al., 2000). Additionally, every movement was demonstrated to the subjects and then repeated several times before being recorded. Subsequently, every subject was asked to carry out the movement twice. The mean value was then estimated from the two recordings.

Due to its low weight and easy installation, the JMA[®] system was not supposed to interfere with mandibular movements and was very well accepted by our subjects.

A defined reference plane was required for this study. We used the arbitrary axis-orbital plane which has been considered suitable by the JMA[®] manufacturers. The arbitrary axis was defined through

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